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Aeolian Dust Captured on Isolated Surfaces along a Transect from the Mojave Desert to the Colorado Plateau, USA

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This study centers on the role of dust with respect to nutrient inputs and influence on hydrologic properties of soil. As such, conditions of dust emission, dust sources, and dust flux under variable climatic and land-use histories bear on interrelations between landscape evolution and ecosystem dynamics. We are examining the causes of local to regional variations in texture and composition of arid-land soils with respect to past and modern dust inputs that may have varied due to changes in climate and dust sources.

In a previous study, aeolian dust was identified in fine-grained sediment captured in small depressions (potholes) on the central Colorado Plateau (Reynolds et al., 2001). The potholes were sampled (typically to 5-cm depth) on high, isolated surfaces to eliminate the possibility of contamination by colluvial or alluvial sedimentation. Primary evidence for the aeolian origin for dust in the pothole sediments was the presence of detrital magnetite, which yielded moderately high magnetic susceptibility (MS). Rocks in which the potholes formed were devoid of magnetite and yield negligible MS values. Physical and chemical properties of dust in these potholes suggested dust sources outside the Colorado Plateau. For example, a high proportion of the silt fraction consists of < 10 µm particles that are characteristic of far-traveled dust, and the content of magnetite and trace elements implied that some dust originated in geologic terrain characterized by felsic igneous rocks, such as the Mojave Desert of southeastern California (Reynolds et al., 2001). The dust in potholes on the Colorado Plateau was not dated. The uppermost samples were collected from biologic soil crust in the upper ~1 cm on a surface that has been stable for over at least 70 years (Belnap and Gardner, 1993); thus, the sampled dust likely represented deposition over the past several centuries to the present day.

The current study was designed to investigate further the possibility that some dust in Colorado Plateau soils originated from sources in the Mojave Desert. Following the strategy of Reynolds et al. (2000), we collected samples from potholes on high, isolated surfaces, developed mostly on Jurassic aeolian sandstone, along a transect from the central Mojave Desert northeast to the original study area on the central Colorado Plateau. Initially, physical and chemical parameters of the silt- and clay-size fraction were compared with those of associated bedrock to confirm the presence of aeolian dust. In addition, the spatial distributions of geochemical and mineralogic parameters in the pothole sediment were examined for regional trends along the southwest-to-northeast transect. If found, such trends might reveal some contribution of Mojave dust sources to fine-grained sediment on the Colorado Plateau.

Magnetic, isotopic, and chemical data indicate the presence of aeolian dust in the potholes. First, MS values for the silt and clay (fines) fraction range from 1.40 x 10^{-6} to 1.59 x 10^{-7} m^3 kg^{-1}, whereas MS values for the associated bedrock is typically < 7.27 x 10^{-9} m^3 kg^{-1}. As in the case of the earlier study, the relatively high MS of the fines in these potholes is generated by the presence of detrital magnetite and titanomagnetite. These minerals are lacking in associated bedrock, and thus must have been deposited as atmospheric dust. Similarly, magnetic measurements of hematite content show much higher hematite contents in the fines compared to those in associated bedrock. Second, $^{87}Sr/^{86}Sr$ values of the carbonate fraction (acetic-acid leach) in the pothole fines range between 0.7082 - 0.7109 and are less radiogenic than are leach fractions from the associated bedrock samples (0.7110 - 0.7144), indicating that the pothole sediment did not originate by weathering of the bedrock. Third, chemical data obtained by inductively coupled plasma spectroscopy (ICP-AES and ICP-MS) show increased elemental content in the pothole fines compared to the bedrock. For example, when all pothole sites are considered together, elemental contents of Ti and Zr in the fine fraction of the pothole sediment is as much as 7x that of the bedrock. Textural data are consistent with the presence of far-traveled dust in the pothole sediments. Silt and clay make up more than 30% of the pothole sediment, in distinct contrast to less than 15% in the bedrock. Normalized distributions within the <63µm size fraction reveal a high proportion of particles <12 µm in diameter. These sizes are typical of particles that are capable of being transported over large distances (>100 km) (Yaalon and Ganor,1973; Goudie, 1978).

Spatial trends are found in some magnetic, chemical, and textural parameters of the potholes fines. MS values (magnetite contents) decrease from southwest to northeast. This trend likely is related to physical sorting during transport of dust from magnetite-rich terrain in arid regions west of the Colorado Plateau. Similarly, Ti, Fe, and Zn generally decrease eastward in abundance. Zr, however, shows an eastward increase. Within the trends of eastward decreasing contents of magnetite and Ti, a few spikes of high MS and correspondingly high values of Ti likely reflect local dust contributions related to nearby exposures of basalt. Finally, the particle-size distribution within the silt fraction is coarser in pothole sediment west of the Colorado Plateau than in pothole sediment on the Colorado Plateau.

Data from fine-grained sediment in potholes on isolated surfaces are consistent with sources of dust in Colorado Plateau soils from the Mojave Desert. As such, processes acting in distant regions, for example the Mojave Desert, can influence ecosystem dynamics hundreds of kilometers away on the Colorado Plateau. However, many other dust sources have surely contributed. Therefore, we need to further evaluate the effects of dilution by dust from local sources on the chemical and magnetic parameters we have measured. Our results suggest that aeolian dust can strongly influence soil geochemistry over large areas of the southwestern U.S. The results also provide insight into the causes of regional variations in texture and composition of arid-land soil with respect to modern ecosystem dynamics.

References

Belnap, J. and J. Gardner. 1993. Soil microstructure in soils of the Colorado Plateau: The role of the cyanobacterium Microcoleus vaginatus. *Great Basin Naturalist* 53:89-95.

Goudie, A.S. 1978. Dust Storms and their geomorphological implications. *Journal of Arid Environments* 1:291-311.

Reynolds, R., J. Belnap, M. Reheis, P. Lamothe, and F. Luiszer. 2001. Aeolian dust in Colorado Plateau soils: Nutrient inputs and recent change in source. *Proceedings of the National Academy of Sciences* 98:7123-7127.

Yaalon, D.H. and E. Ganor. 1973. The influence of dust on soils during the Quaternary. *Soil Science* 116:146-155.